In epidemics, one or two severe defoliations kill many trees outright, kill the tops of many more, and leave still others in a lingering, unhealthy condition to be killed by other insects or disease.

The cause of tussock moth epidemics is not completely understood, but entomologists believe that a crucial factor is the delicate balance between the insect's high reproductive rate and a natural high mortality rate (the tussock moth has many natural enemies, including both insect parasites and disease). Under natural forest conditions, tussock moths tend to be present in either epidemic numbers or in very low numbers. If some change in the environment permits a few more female tussock moths than usual to lay eggs, the increase in the number of moths in the following generation can be quite startling. A five-fold increase per generation is not uncommon.

Once epidemics of Douglas-fir tussock moths become established it is difficult for the natural enemies to reproduce fast enough to reduce the tussock moth population to its usual low level.

Therefore, once an epidemic is established, it usually persists from three to five years until a disease (a polyhedrosis virus) becomes dominant. This disease can be exceedingly virulent in dense tussock moth populations, and usually terminates epidemics within a year after the virus becomes evident.

POSSIBLE CONTROL METHODS

The destructive potential of the Douglas-fir tussock moth is so great that the Forest Service has conducted extensive research on possible control methods. DDT is the only method of control which has been used previously and proven effective against the tussock moth. However, the Forest Service has not used DDT to control tussock moths in the United States since 1965 because of the persistence of this chemical in the environment. Instead, the Forest Service has conducted extensive research on improved methods and materials to replace DDT.

The goal of forest insect control is not to eradicate the offending insects completely, but to reduce the populations to tolerable levels. This can be done best by using a method known as "integrated" control. This means the judicious use of two or more control methods—in combination—to achieve the desired effects. In the case of the tussock moth, two possible controls have been developed through Forest Service research programs. Both have excellent potential for safe, effective control.

A research unit located at the Forest Science Laboratory in Corvallis, Oregon, has been working with a natural enemy of the tussock moth—the polyhedrosis virus referred to earlier—to determine if it can be used to check populations of the moth before they reach epidemic proportions. If successful, this might be an ideal means of biological control. No pollution would be involved, and since there is no indication that the disease attacks plants, animals, or other insects, it is considered very safe.

The other control method being studied is use of pyrethrins, materials derived from chrysanthemum flowers. A Forest Service research unit in Berkeley, California, has tested pyrethrins against many forest insects, including the tussock moth, and found them very effective. Pyrethrins have not been used in forest insect control previously because they were unstable in sunlight and broke down too rapidly to be effective outdoors. Now scientists with the Berkeley research group have added stabilizers, essentially a "sunscreen," to the insecticide formulation which enable it to remain active longer. With the sunscreen, pyrethrins can be stabilized for 24 to 48 hours. Without stabilizers, all activity is gone within 2 to 4 hours.

Pyrethrins have been used for controlling insects indoors since the first Century. They have been labeled non-toxic by the Food and Drug Administration and are considered so safe that they are used in household insect sprays and to protect stored food products.

The current infestations of tussock moths in the Eldorado and Sierra National Forests, and adjacent Yosemite National Park, provide an excellent opportunity for small-scale tests of both of these new methods for management of tussock moth populations. Researchers believe that both treatments can effectively reduce epidemics of the tussock moth, and field tests are necessary in order to determine the effectiveness of these treatments in the woods.

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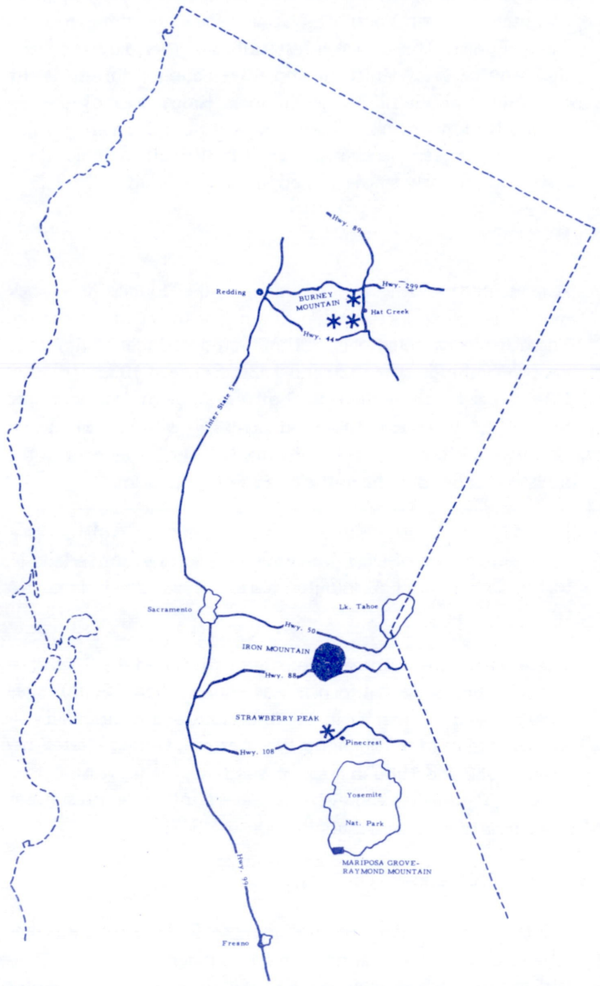

Known infestations of DOUGLAS-FIR TUSSOCK MOTHS IN CALIFORNIA

MAIN INFESTATION

SPOT INFESTATIONS *

4500-6
Douglas-fir TH
LGL-3-6
1528 ✓

DOUGLAS-FIR

TUSSOCK MOTH

IN CALIFORNIA FORESTS 1970-1971

Forest Service
California Region
USDA

TUSSOCK MOTH: A THREAT TO CALIFORNIA FORESTS

The year 1970 was a favorable one for the Douglas-fir tussock moth, and its population increased dramatically in California forests. Known to scientists as *Hemerocampa pseudotsugata* McDunnough, this insect feeds on the needles of white fir trees in the caterpillar (larval) stage of its life. In other areas of the West it also feeds on Douglas-fir needles. This insect is carefully watched by forest entomologists because of its ability to increase rapidly in number and cause widespread damage to fir forests before natural control factors can regain the upper hand.

Normally, a limited number of these moths are present in the forest and cause little damage. Low populations of this type have been under observation near Hat Creek, California, for over two years. In the summer of 1970, greater populations of the Douglas-fir tussock moth were discovered in forests near Burney Mountain, Iron Mountain, Strawberry Peak, and Mariposa Grove-Raymond Mountain (see map). The most serious damage so far has been in the Mariposa Grove-Raymond Mountain area of Yosemite National Park and the Sierra National Forest. The largest infestation, however, covers several thousand acres of white fir and mixed-conifer forests in the Iron Mountain-Baltic Ridge-Plummer Ridge area of the Eldorado National Forest. There may be other infestations which have not yet been discovered since it is difficult to detect these insects in the early stages of a population buildup.

HISTORY

As a result of several serious epidemics, the Douglas-fir tussock moth has earned a reputation as a major forest insect enemy. Tussock moths killed over 300 million board feet of timber in eastern Washington in 1929 and 1930. Between 1934 and 1938 they caused severe damage, both in growth loss and tree mortality, to several thousand acres of white fir in Mono County, California. In this epidemic, nearly 30 percent of the infested timber died from the effects of defoliation.

In 1947, the tussock moth was the target of the first large-scale aerial application of DDT when 500,000 acres of timberland in Idaho, Oregon, and Washington were sprayed to halt a massive epidemic.

The next serious outbreak, detected in 1954 on the Stanislaus National Forest in California, was ended when 10,000 acres were sprayed by aircraft in 1956. Serious and widespread epidemics occurred throughout the Western United States between 1962 and 1966 in areas of Montana, Idaho, Washington, Oregon, California, and Arizona. Several of these infestations were treated with aerial applications of DDT.

ECOLOGICAL FACTORS

The Douglas-fir tussock moth is an insect which passes through four stages in its annual life cycle (see diagram). The eggs are laid in the fall, and they hatch in the spring when the tender new tree foliage is growing. The tiny caterpillars are exceedingly hairy and are easily dispersed by wind—like pieces of lint. These small larvae feed on the new needles of the trees which causes them to shrivel and die. Later, when the caterpillars have increased several times in size, they consume both the new and older needles, often causing complete defoliation of severely infested trees.

Severe damage occurs first in the tops of trees. Then as the size and appetite of the caterpillars increase, foliage disappears at progressively lower levels. In August and September, the caterpillars spin hairy cocoons attached to tree branches and foliage. Inside these cocoons, the larvae metamorphose into adult moths. The male moths are able to fly about, but the females have only rudimentary wings and are nearly immobile. After the females emerge from the cocoon, they mate, and deposit eggs on top of their own cocoon.

SEPT.-OCT.: Pupae transform to grayish-colored moths. The male has well-developed wings and can fly. The female has very small wings and cannot fly.

SEPT.-OCT.: Female moth lays eggs in masses (up to 240 per mass) on the cocoon from which she emerges. The insects overwinter in the egg stage.

LIFE CYCLE OF THE DOUGLAS-FIR TUSSOCK MOTH

LATE AUG.: When feeding is complete, the caterpillars transform to pupae within cocoons.

LATE JUNE-AUG.: Eggs hatch and the caterpillars begin feeding.

AUG.: The caterpillars kill fir trees by eating the foliage.